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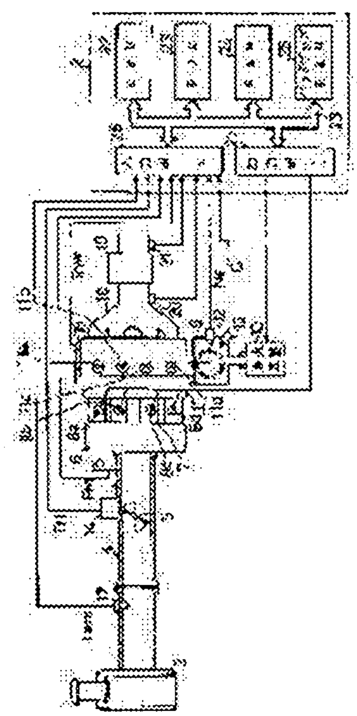
(54) CONTROL APPARATUS FOR INTERNAL COMBUSTION ENGINE



(57)Abstract:
PURPOSE: To provide a control apparatus for internal combustion engine, of which the air-fuel ratio can be quickly made a theoretical air-fuel ratio upon commencement and completion of the injection dither.
CONSTITUTION: ECU2, during the time period in which the warming-up of a catalyst 19 is not completed, performs its catalyst warming-up operation through adjustment of the fuel injection quantity so that the air-fuel ratio may be compulsively inclined toward the rich and lean side, alternately, from the theoretical air-fuel ratio for each specified time period. Further, when starting the catalyst warming-up operation, the ECU2 sets a first air-fuel ratio feedback control constant (initial value of the skip quantity) for making the central air-fuel ratio the theoretical air-fuel ratio. When completing the catalyst warming-up operation, the ECU2 sets a second air-fuel feedback control constant (initial value of the skip quantity) for making the central air-fuel ratio the theoretical air-fuel ratio.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an internal combustion engine's control device, and relates to the engine control system for carrying out warming up of the catalyst which purifies exhaust gas at an early stage in detail.
[0002]
[Description of the Prior Art] Conventionally, an oxygen density detector is installed in the style of [of a three way component catalyst] the upper and lower sides, according to the output signal of the oxygen density detector of the upstream, the delay time of the richness by the upstream oxygen density detector and the Lean judging is adjusted, or the constant of air-fuel ratio feedback is changed, and the system which controls a main air-fuel ratio to theoretical air fuel ratio (lambda= 1) is proposed (for example, JP,61-234241,A).
[0003] On the other hand, by fluctuating the amount of supply compulsorily and considering as the last injection by Japanese Patent Application No. No. 18695 [three to], previously, an applicant for this patent makes exothermic reaction perform compulsorily, and does early warming up of the catalyst. This is defined as an injection dither (dither).

[0004] And by combining these two techniques, while making early warming up of a catalyst possible, it is possible to build the system which controls a main air-fuel ratio to theoretical air fuel ratio (lambda= 1). That is, as shown in drawing 14 , while carrying out feedback control using the oxygen density detector of the upstream of a three way component catalyst, fluctuation of an air-fuel ratio arises by the injection dither, and when delay occurs in the Rich Lean judging by air-fuel ratio feedback, a feedback period becomes long (it sets to drawing 14 and is T1 <T2) and this period becomes long, a main air-fuel ratio shifts a fluctuated part of a fuel. However, a main air-fuel ratio can be completed as theoretical air fuel ratio with the oxygen density detector of the downstream of a three way component catalyst by correcting gradually the amount RSR of rich skips, and the amount RSL of RIN skips.
[0005]
[Problem(s) to be Solved by the Invention] However, in this system, although amended using the output of the oxygen density detector of the downstream, as shown in drawing 14 , to a rapid change of an air-fuel ratio, an early action cannot be performed like [at the time of initiation of dither control, or termination].
[0006] Then, the purpose of this invention is to offer an internal combustion engine's control unit which can be promptly made into theoretical air fuel ratio in the case of initiation and termination of an injection dither.
[0007]
[Means for Solving the Problem] The fuel injection valve M1 to which the 1st invention injects a fuel to an internal combustion engine as shown in drawing 15 , The catalyst M2 for being arranged by an internal combustion engine's exhaust pipe and purifying exhaust gas, A standby detection means M3 to detect the standby of said catalyst M2, and an operational status detection means M4 to detect an internal combustion engine's operational status, The 1st air-fuel ratio sensor M5 which is prepared in the upstream of said catalyst M2, and detects the specific constituent concentration in exhaust gas, The 2nd air-fuel ratio sensor M6 which is prepared in the downstream of said catalyst M2, and detects the specific constituent concentration in exhaust gas, The fuel-injection control means M7 which controls said fuel injection valve M1 in order to make the fuel injection of the amount according to the operational status of the internal combustion engine by said operational status detection means M4 perform, According to the output of said 1st air-fuel ratio sensor M5, so that an air-fuel ratio may become narrow within the limits near the

theoretical air fuel ratio The air-fuel ratio feedback means M8 which adjusts the fuel oil consumption by said fuel-injection control means M7, and carries out feedback amendment of the air-fuel ratio, According to the output of said 2nd air-fuel ratio sensor M6, so that the main air-fuel ratio by said air-fuel ratio feedback means M8 may approach theoretical air fuel ratio In the condition that warming up of said catalyst M2 is not completed with a controlled parameter modification means M9 to change an air-fuel ratio feedback controlled parameter, and said standby detection means M3 So that an air-fuel ratio may be on the rich and Lean side to theoretical air fuel ratio for every predetermined period compulsorily A catalyst warming-up means M10 to adjust the fuel oil consumption by said fuel-injection control means M7, and to perform catalyst warming-up processing, The 1st air-fuel ratio feedback controlled parameter for making the main air-fuel ratio by said air-fuel ratio feedback means M8 into theoretical air fuel ratio, when starting the catalyst warming-up processing by said catalyst warming-up means M10 is set up. When you end catalyst warming-up processing, let the control unit of the internal combustion engine having a controlled parameter setting means M11 to set up the 2nd air-fuel ratio feedback controlled parameter for making the main air-fuel ratio by said air-fuel ratio feedback means M8 into theoretical air fuel ratio be the summary.

[0008] The fuel injection valve 21 to which the 2nd invention injects a fuel to an internal combustion engine as shown in drawing 16 , The catalyst 22 for being arranged by an internal combustion engine's exhaust pipe and purifying exhaust gas, A standby detection means M23 to detect the standby of said catalyst 22, and an operational status detection means M24 to detect an internal combustion engine's operational status, The 1st air-fuel ratio sensor M25 which is prepared in the upstream of said catalyst M22, and detects the specific constituent concentration in exhaust gas, The 2nd air-fuel ratio sensor M26 which is prepared in the downstream of said catalyst M22, and detects the specific constituent concentration in exhaust gas, It responds to the output of the fuel-injection control means which controls said fuel injection valve M21 in order to make the fuel injection of the amount according to the operational status of the internal combustion engine by said operational status detection means M24 perform, and the M27 and said 1st air-fuel ratio sensor M25. The air-fuel ratio feedback means M28 which adjusts the fuel oil consumption by said fuel-injection control means M27, and carries out feedback amendment of the air-fuel ratio so that an air-fuel ratio may become narrow within the limits near the theoretical air fuel ratio, According to the output of said 2nd air-fuel ratio sensor M26, so that the main air-fuel ratio by said air-fuel ratio feedback means M28 may approach theoretical air fuel ratio In the condition that warming up of said catalyst M22 is not completed with a time delay modification means M29 to change the time delay of an output judging of the 1st air-fuel ratio sensor M25 in said air-fuel ratio feedback means M28, and said standby detection means M23 So that an air-fuel ratio may be on the rich and Lean side to theoretical air fuel ratio for every predetermined period compulsorily A catalyst warming-up means M30 to adjust the fuel oil consumption by said fuel-injection control means M27, and to perform catalyst warming-up processing, When starting the catalyst warming-up processing by said catalyst warming-up means M30, in order to make the main air-fuel ratio by said air-fuel ratio feedback means M28 into theoretical air fuel ratio, the 1st time delay is set up as a time delay of an output judging of the 1st air-fuel ratio sensor M25. In order to make the main air-fuel ratio by said air-fuel ratio feedback means M28 into theoretical air fuel ratio, when ending catalyst warming-up processing Let the control unit of the internal combustion engine characterized by having a time delay setting means M31 to set up the 2nd time delay as a time delay of an output judging of the 1st air-fuel ratio sensor M25 be the summary.

[0009]

[Function] A fuel injection valve M1 is controlled so that the fuel-injection control means M7 may make the fuel injection of the amount according to the operational status of the internal combustion engine by the operational status detection means M4 perform [invention / 1st]. Moreover, according to the output of the 1st air-fuel ratio sensor M5, the air-fuel ratio feedback means M8 adjusts the fuel oil consumption by the fuel-injection control means M7, and carries out feedback amendment of the air-fuel ratio so that an air-fuel ratio may become narrow within the limits near the theoretical air fuel ratio. Furthermore, according to the output of the 2nd air-fuel ratio sensor M6, the controlled parameter modification means M9 changes an air-fuel ratio feedback controlled parameter so that the main air-fuel ratio by the air-fuel ratio feedback means M8 may approach theoretical air fuel ratio.

[0010] And in the condition that warming up of a catalyst M2 is not completed with the standby detection means M3, the catalyst warming-up means M10 adjusts the fuel oil consumption by the fuel-injection control means M7, and performs catalyst warming-up processing so that an air-fuel ratio may be on the rich and Lean side to theoretical air fuel ratio for every predetermined period compulsorily. That is, make rich combustion with an internal combustion engine, and the Lean combustion repeat, generate heat in the oxidation reaction by the carbon monoxide generated at

the time of rich combustion, and the oxygen generated at the time of the Lean combustion, a catalyst is made to heat with this heat, and warming up of the catalyst is carried out at an early stage.
[0011] Moreover, the controlled parameter setting means M11 sets up the 1st air-fuel ratio feedback controlled parameter for making the main air-fuel ratio by the air-fuel ratio feedback means M8 into theoretical air fuel ratio, when starting the catalyst warming-up processing by the catalyst warming-up means M10, and when ending catalyst warming-up processing, it sets up the 2nd air-fuel ratio feedback controlled parameter for making the main air-fuel ratio by the air-fuel ratio feedback means M8 into theoretical air fuel ratio. That is, the 1st air-fuel ratio feedback controlled parameter when performing catalyst warming-up processing from the condition of omitting catalyst warming-up processing, By choosing an air-fuel ratio feedback controlled parameter, if the 2nd air-fuel ratio feedback controlled parameter when not performing catalyst warming-up processing from the condition of performing catalyst warming-up processing is prepared as a different value and a switch is performed A main air-fuel ratio can be brought close to theoretical air fuel ratio more promptly.
[0012] A fuel injection valve M21 is controlled so that the fuel-injection control means M27 may make the fuel injection of the amount according to the operational status of the internal combustion engine by the operational status detection means M24 perform [invention / 2nd]. Moreover, according to the output of the 1st air-fuel ratio sensor M25, the air-fuel ratio feedback means M28 adjusts the fuel oil consumption by the fuel-injection control means M27, and carries out feedback amendment of the air-fuel ratio so that an air-fuel ratio may become narrow within the limits near the theoretical air fuel ratio. Furthermore, according to the output of the 2nd air-fuel ratio sensor M26, the time delay modification means M29 changes the time delay of an output judging of the 1st air-fuel ratio sensor M25 in the air-fuel ratio feedback means M28 so that the main air-fuel ratio by the air-fuel ratio feedback means M28 may approach theoretical air fuel ratio.
[0013] And in the condition that warming up of a catalyst M22 is not completed with the standby detection means M23, the catalyst warming-up means M30 adjusts the fuel oil consumption by the fuel-injection control means M27, and performs catalyst warming-up processing so that an air-fuel ratio may be on the rich and Lean side to theoretical air fuel ratio for every predetermined period compulsorily. That is, make rich combustion with an internal combustion engine, and the Lean combustion repeat, generate heat in the oxidation reaction by the carbon monoxide generated at the time of rich combustion, and the oxygen generated at the time of the Lean combustion, a catalyst is made to heat with this heat, and warming up of the catalyst is carried out at an early stage.
[0014] Moreover, when starting the catalyst warming-up processing by the catalyst warming-up means M30, in order that the time delay setting means M31 may make the main air-fuel ratio by the air-fuel ratio feedback means M28 theoretical air fuel ratio, the 1st time delay is set up as a time delay of an output judging of the 1st air-fuel ratio sensor M25. When ending catalyst warming-up processing, in order to make the main air-fuel ratio by the air-fuel ratio feedback means M28 into theoretical air fuel ratio, the 2nd time delay is set up as a time delay of an output judging of the 1st air-fuel ratio sensor M25. That is, when the 1st time delay when performing catalyst warming-up processing from the condition of omitting catalyst warming-up processing, and the 2nd time delay when not performing catalyst warming-up processing from the condition of performing catalyst warming-up processing are prepared as a different value and a switch is performed, a main air-fuel ratio can be more promptly brought close to theoretical air fuel ratio by choosing a time delay.
[0015]
[Example]
(The 1st example) One example which materialized this invention is hereafter explained according to a drawing.
[0016] Drawing 1 is the outline block diagram showing the engine 1 with which fuel-injection control and ignition timing control are performed, and its peripheral device. In this example, the ignition timing AESA of an engine 1 and control of fuel oil consumption TAU are performed by the electronic control (henceforth ECU) 2 so that it may illustrate.
[0017] An engine 1 is the thing of the jump-spark-ignition type of a 4-cylinder four cycle, and the inhalation air is inhaled by each gas column from the upstream through an air cleaner 3, an inlet pipe 4, a throttle valve 5, a surge tank 6, and the inhalation-of-air branch pipe 7.
[0018] On the other hand, the fuel is constituted so that it may be injected and supplied from the fuel injection valves 8a, 8b, 8c, and 8d which were fed from the fuel tank which is not illustrated and were prepared in the inhalation-of-air branch pipe 7. Moreover, a distributor 9 is formed in an engine 1 and the electrical signal of the high voltage offered

from a firing circuit 10 is distributed to the ignition plugs 11a, 11b, 11c, and 11d of each gas column.
[0019] Furthermore, in a distributor 9, the engine-speed sensor 12 and the gas column distinction sensor 13 are attached, and the engine-speed sensor 12 detects the engine speed Ne of an engine 1. That is, the engine-speed sensor 12 counters the ring gear rotated synchronizing with the crankshaft of an engine 1, is formed, and outputs the pulse signal of 24 shots to two rotations (namely, 720degree-CA) of an engine 1 in proportion to an engine speed Ne. The gas column distinction sensor 13 distinguishes the gas column of an engine 1. That is, the link gear which the gas column distinction sensor 13 also rotates synchronizing with the crankshaft of an engine 1 is countered, it is prepared, and pulse signal [of one shot] G is outputted to two rotations (namely, 720degree-CA) of an engine 1 in the compression top dead center of a predetermined gas column.
[0020] The throttle sensor 14 outputs the idle signal which shows that a throttle valve 5 is a close by-pass bulb completely mostly while outputting the analog signal according to the opening TH of a throttle valve 5. The intake-pressure sensor 15 detects the intake pressure PM of the lower stream of a river of a throttle valve 5. The warming-up sensor 16 detects the cooling water temperature Thw of an engine 1, and an intake temperature sensor 17 detects an intake-air temperature Tam.
[0021] Furthermore, the three way component catalyst 19 for reducing the injurious ingredients in the exhaust gas discharged from an engine 1 (CP, HC, NOx, etc.) is formed in the exhaust pipe 18 of an engine 1.
[0022] Furthermore, the air-fuel ratio sensor 20 which is an oxygen density sensor which outputs the linear detecting signal according to the air-fuel ratio lambda of the gaseous mixture supplied to the engine 1 is formed in the upstream of a three way component catalyst 19. Furthermore, the air-fuel ratio sensor 21 which is an oxygen density sensor which outputs the linear detecting signal according to the air-fuel ratio lambda of the gaseous mixture supplied to the engine 1 is formed in the downstream of a three way component catalyst 19.
[0023] ECU2 is constituted as an arithmetic logic operation circuit focusing on well-known CPU22, ROM23 and RAM24, and backup RAM25 grade, and is mutually connected with the output port 27 grade which outputs the control signal to input port 26 and each actuator which perform the input from each sensor mentioned above through the bus 28.
[0024] Through input port 26, ECU2 inputs an intake pressure PM, an intake-air temperature Tam, the throttle opening TH, the cooling water temperature Thw, an air-fuel ratio lambda, a rotational frequency Ne, etc., computes the amount TAU of fuel jet, and ignition timing AESA based on these, and outputs a control signal to each of fuel injection valves 8a-8d and a firing circuit 10 through an output port 27.
[0025] Next, an operation of an internal combustion engine's control unit constituted in this way is explained. It faces explaining this operation and the timing chart of drawing 8 R> 8 is used. in addition, the control which does not have an injection dither in drawing 8 before the timing of t6' -- it is -- t6' -- injection dither control shall be performed henceforth
[0026] moreover -- the time of reversing richly the air-fuel ratio sensor (O2 sensor) 20 of the upstream from Lean to an actual air-fuel ratio, as shown in drawing 8 -- delay tau 1 **** -- the time of being reversed to Lean, since rich [get down and] -- delay tau 2 **** -- it is.
[0027] Judgment processing of fuel-injection dither control is shown in drawing 2 , and this processing is performed every 40msec(s). This fuel-injection dither control is processing for early warming up of a three way component catalyst 19. That is, rich combustion and the Lean combustion are repeated by making fuel oil consumption fluctuate for every combustion, and shaking an air-fuel ratio at the rich and Lean side to theoretical air fuel ratio, and oxygen (O2) is generated by the carbon monoxide (CO) and the Lean combustion by rich combustion. And the carbon monoxide and oxygen which were generated in this way perform the oxidation reaction shown in the following formulas, and generate heat (Q).
[0028]
[Equation 1]
2 CO+O2 =2CO2+Q -- exhaust gas temperature rises with the heat (Q) generated by this oxidation reaction, and warming up of a three way component catalyst 19 is promoted.
[0029] More specifically at step 100 of drawing 2 , it distinguishes whether the engine 1 carried out after [the completion of starting] (for example, Ne>500rpm) predetermined time progress. This predetermined time is time amount until a three way component catalyst 19 reaches the temperature which performs an emission cleaning effect, for example, is set as 100 seconds.

[0030] dither distinction flag FDit which will read the cooling water temperature Thw at step 101 if it becomes by the predetermined within a time one at step 100, and shows whether it distinguished that it was within the limits whose cooling water temperature Thw is 20-60 degrees C, and the operation conditions of an injection dither were satisfied when it was within the limits It sets (= 1) and this routine is ended.
[0031] Moreover, if it has separated at step 101 from the range whose cooling water temperature Thw is 20-60 degrees C, it is [the case where having carried out after / the completion of starting / predetermined time progress at step 100 is distinguished, and] the dither distinction flag FDit at step 102. It clears (= 0) and this routine is ended.
[0032] Next, based on drawing 3 , the operation approach of the last fuel oil consumption TAU is explained. This routine is started for every injection timing. First, an engine speed Ne and an intake pressure PM are read at steps 200 and 201, and it is the dither distinction flag FDit at step 202. It distinguishes whether it is set (= 1).
[0033] Dither distinction flag FDit When set, air-fuel ratio feedback conditions distinguish that it is formation at step 203. Here, an engine speed Ne is below the predetermined value Neo (Ne<Neo), an intake pressure PM is below the predetermined value PMo (PM<PMo), and, as for air-fuel ratio feedback conditions, water temperature Thw says 20 degrees C or more (Thw> 20 degrees C).
[0034] And if air-fuel ratio feedback conditions are satisfied, it will distinguish whether the dither check flag Fri which means last time whether the air-fuel ratio was shaken at the rich side or it shook at the Lean side in step 205 is set (= 1).

[0035] Processing which sets an air-fuel ratio to a rich side is performed at step 206 this time noting that an air-fuel ratio will be shaken at the Lean side last time, if the dither check flag Fri is set. That is, it is referred to as last dither multiplier CDit =1.1. Furthermore, the dither check flag Fri is reset at step 207 (= 0).
[0036] Moreover, processing which sets an air-fuel ratio to the Lean side is performed at step 208 this time noting that an air-fuel ratio will be shaken at a rich side last time, if the dither check flag Fri is reset at step 205 (= 0). That is, it is referred to as last dither multiplier CDit =0.9. Furthermore, the dither check flag Fri is set at step 209 (= 1).
[0037] In addition, when air-fuel ratio feedback conditions are not satisfied at the case of dither distinction flag FDit =0, and step 203 in said step 202, it is referred to as last dither multiplier CDit =1.0 at step 204.
[0038] Furthermore, the basic injection quantity TP memorized by the two-dimensional map from the engine speed Ne and the intake pressure PM at step 210 is computed after processing of step 204,207,209.
[0039] and the step 211 -- the last fuel oil consumption TAU -- the basic injection quantity TP, the air-fuel ratio correction factor FAF, and the last dither multiplier CDit A multiplier alpha and invalid injection time Tv from -- it computes from the following operation expression. However, a multiplier alpha is determined by water temperature Thw, an engine speed Ne, and with-time rate-of-change deltaPM of an intake pressure.
[0040]
[Equation 2]
The last fuel oil consumption TAU is set at TAU=TP-FAF-CDit, +Tv, and step 212, and this routine is ended.
[0041] Thus, an air-fuel ratio is shaken at the rich side and Lean side for every combustion. Consequently, a catalyst carries out warming-up completion at an early stage, and atmospheric-air emission of the injurious ingredient in exhaust gas is reduced.
[0042] Drawing 4 and 5 are 1st air-fuel ratio feedback control routine which calculates the air-fuel ratio correction factor FAF based on the output of the air-fuel ratio sensor 20 of the upstream, and are performed by every predetermined time (for example, 10msec).
[0043] At step 300, it distinguishes whether the feedback control conditions (it is the same as said step 203) of an air-fuel ratio are satisfied. And when feedback control conditions are abortive, it progresses to step 301, and the air-fuel ratio correction factor FAF is set to 1.0. On the other hand, in feedback control condition formation, it shifts to step 302.
[0044] At step 302, it is the output V1 of the air-fuel ratio sensor 20 of the upstream. A/D conversion is carried out, and it incorporates and is step 303V1. It distinguishes whether it is below the comparison electrical potential difference VR 1 (for example, 0.45V). That is, an air-fuel ratio distinguishes Rich or Lean. If it is Lean (V1 <=VR1), "1" decrement of the delay counter CDLY is carried out at step 304, and the delay counter CDLY is guarded at the minimum value TDR by step 305,306. In addition, even if the minimum value TDR has the change to Rich from Lean in the output of the air-fuel ratio sensor 20 of the upstream, it is a rich time delay for holding decision that it is in the Lean condition, and it is defined by the negative value.

[0045] On the other hand, if it is rich (V1 >VR1) in step 303, "1" increment of the delay counter CDLY is carried out at step 307, and the delay counter CDLY is guarded at Maximum TDL by step 308,309. In addition, since Maximum TDL is rich in the output of the air-fuel ratio sensor 20 of the upstream, even if it has change to Lean, it is the Lean time delay for holding decision that it is in a rich condition, and it is defined by the forward value.
[0046] Here, the criteria of the delay counter CDLY are set to "0", it considers that the air-fuel ratio after delay processing is rich at the time of CDLY>=0, and it is considered at the time of CDLY<0 that the air-fuel ratio after delay processing is Lean.
[0047] At step 310 of drawing 5 , it distinguishes whether the sign of the delay counter CDLY was reversed. That is, it distinguishes whether the air-fuel ratio after delay processing was reversed. If the air-fuel ratio is reversed, it is the dither distinction flag FDit at step 311. If it judges whether it is "1" and becomes FDit =0, while setting up the value RSR1 beforehand defined as an amount RSR of skips at step 312, the value RSL1 beforehand defined as an amount RSL of skips will be set up. Moreover, if it becomes dither distinction flag FDit =1 at step 311, while setting up the value RSR2 beforehand defined as an amount RSR of skips at step 313, the value RSL2 beforehand defined as an amount RSL of skips will be set up.
[0048] And at step 314, since rich, the reversal to Lean and the reversal to Rich from Lean is distinguished. Since rich, if it is reversal to Lean, it will be made to increase in skip with FAF=FAF+RSR at step 315, and if it is reversal to Rich from Lean, it will be made to decrease in skip with FAF=FAF-RSL at step 516 conversely. That is, skip processing is performed (timing of t2, t3, t4, t5, and t6 in drawing 8). .
[0049] On the other hand, if the sign of the delay counter CDLY is not reversed in step 310, integral processing is performed at step 317,318,319. That is, it distinguishes whether it is CDLY<0 at step 317, if it is CDLY<0 (Lean), it will consider as FAF=FAF+K1 at step 318, and on the other hand, if it is CDLY>=0 (rich), it will consider as FAF=FAF-K1 at step 319. Here, the integration constant K1 is set up sufficiently small compared with the skip constant RS, that is, is K1<<RS. Therefore, step 318 increases fuel oil consumption gradually in the state of Lean (CDLY<0) (t2 -t3 in drawing 8 , t4 -t5), and step 319 decreases fuel oil consumption gradually in the rich condition (CDLY>=0) (t1 -t2 in drawing 8 , t3 -t4, t5 -t6).
[0050] In addition, it prevents the air-fuel ratio correction factor FAF calculated at step 315,316,318,319 controlling an engine's air-fuel ratio by the value, and becoming excess richness and exaggerated RIN, when it shall guard at the minimum value (for example, 0.8) and maximum (for example, 1.2), and the air-fuel ratio correction factor FAF becomes large too much by a certain cause by this or it becomes small too much.
[0051] Like ****, calculated FAF is stored in RAM24 and a routine is ended. Drawing 6 and 7 are 2nd air-fuel ratio feedback control routine which calculates the amounts RSR and RSL of skips based on the output of the air-fuel ratio sensor 21 of the downstream, and are performed by every predetermined time (for example, 100msec).
[0052] At step 400, it distinguishes whether the feedback control conditions (it is the same as said step 203) of the air-fuel ratio by the air-fuel ratio sensor 21 of the downstream are satisfied. And this routine will be ended if it is air-fuel ratio feedback control condition failure.
[0053] Moreover, if it is air-fuel ratio feedback control condition formation, it progresses to step 401 and is the output voltage V2 of the air-fuel ratio sensor 21 of the downstream. A/D conversion is carried out, and it incorporates and is the dither distinction flag FDit at step 402. It judges whether it is "1."
[0054] And if it becomes FDit =0, it will be the output voltage V2 of the air-fuel ratio sensor 21 of the downstream at step 416 of drawing 7 . It distinguishes whether it is below the comparison electrical potential difference VR 2 (for example, 0.55V). That is, an air-fuel ratio distinguishes Rich or Lean. In addition, since each air-fuel ratio sensors 20 and 21 hit before and after a catalyst, the comparison electrical potential difference VR 2 in step 416 is set up in consideration of the output characteristics under the effect of raw gas, and the output characteristics accompanying the difference in the rate of degradation more highly than the comparison electrical potential difference VR 1 in step 303 of drawing 4 .
[0055] At the time of Lean (V2 <=VR2), it is referred to as RSR1=RSR1+deltaRS (constant value) at step 417 by step 416, that is, the amount RSR of rich skips is increased, and an air-fuel ratio is made to shift to a rich side. In step 418,419, RSR is guarded at Maximum MAX. Furthermore, it is referred to as RSL1=RSL1-deltaRS (constant value) at step 420. That is, the amount RSL of rich skips is decreased and an air-fuel ratio is made to shift to a rich side. In step 421,423, RSL1 is guarded at the minimum value MIN.
[0056] On the other hand, when rich (V2 >VR2) in step 416, it is referred to as RSR1=RSR1-deltaRS (constant value)

at step 423, that is, the amount RSR of rich skips is decreased, and an air-fuel ratio is made to shift to the Lean side. In step 424,425, RSR is guarded at the minimum value MIN. Furthermore, it is referred to as RSL1=RSL1+deltaRS (constant value) at step 426, that is, the amount RSL of RIN skips is made to increase, and an air-fuel ratio is made to shift to the Lean side. In step 427,428, RSL is guarded at Maximum MAX.
[0057] On the other hand, if it becomes dither distinction flag FDit=1 in step 402 of drawing 6 , it will be the output voltage V2 of the air-fuel ratio sensor 21 of the downstream. It distinguishes whether it is below the comparison electrical potential difference VR 2 (for example, 0.55V). That is, an air-fuel ratio distinguishes Rich or Lean.
[0058] In step 403, it is referred to as RSR2=RSR2+deltaRS (constant value) at step 404 at the time of Lean (V2 <=VR2), that is, the amount RSR2 of rich skips is increased, and an air-fuel ratio is made to shift to a rich side. In step 405,406, RSR2 is guarded at Maximum MAX. Furthermore, it is referred to as RSL2=RSL2-deltaRS (constant value) at step 407. That is, the amount RSL of RIN skips is decreased and an air-fuel ratio is made to shift to a rich side. In step 408,409, RSL2 is guarded at the minimum value MIN.
[0059] On the other hand, when rich (V2 >VR2) in step 403, it is referred to as RSR2=RSR2-deltaRS (constant value) at step 410, that is, the amount RSR of rich skips is decreased, and an air-fuel ratio is made to shift to the Lean side. In step 411,412, RSR is guarded at the minimum value MIN. Furthermore, it is referred to as RSL2=RSL2+deltaRS (constant value) at step 413, that is, the amount RSL of RIN skips is made to increase, and an air-fuel ratio is made to shift to the Lean side. In step 414,415, RSL is guarded at Maximum MAX.
[0060] Like ****, RSR and RSL which were calculated are stored in RAM24, and this routine is ended. In addition, drawing 6 and the minimum value MIN in 7 are values equivalent to level (for example, 3%) by which transient flattery nature is not spoiled, and Maximum MAX is a value equivalent to level (for example, 10%) which aggravation of DORABIRITI by air-fuel ratio fluctuation does not generate.
[0061] Thus, if the output of the air-fuel ratio sensor 21 of the downstream is Lean according to drawing 6 and the routine of 7, the amount RSR of rich skips will increase gradually, and the amount RSL of RIN skips will decrease gradually, and, thereby, an air-fuel ratio will shift to a rich side. Moreover, if the output of the air-fuel ratio sensor 21 of the downstream is rich, the amount RSR of rich skips will decrease gradually, and the amount RSL of RIN skips will increase gradually, and, thereby, an air-fuel ratio will shift to the Lean side.
[0062] At this time, when RSR2 and RSL2 were computed by processing at step 417,420,423,426 in drawing 7 when there is no injection dither, and there was an injection dither, RSR1 and RSL1 were computed by processing at step 404,407,410,413 in drawing 7 . That is, two kinds of multipliers which determine the amount of skips are prepared by the existence of a dither, and are chosen.
[0063] Thus, in this example, ECU2 adjusts fuel oil consumption and carries out feedback amendment of the air-fuel ratio according to the output of the air-fuel ratio sensor 20, so that an air-fuel ratio may become narrow within the limits near the theoretical air fuel ratio, while it controls fuel injection valves 8a-8d so that it may make the fuel injection of the amount according to the operational status of an engine 1 perform. Moreover, according to the output of the air-fuel ratio sensor 21, ECU2 changes the amount of skips as an air-fuel ratio feedback controlled parameter, further, adjusts fuel oil consumption and performs catalyst warming-up processing so that an air-fuel ratio may be on the rich and Lean side to theoretical air fuel ratio in the condition that warming up of a catalyst 19 is not completed, for every predetermined period compulsorily, so that a main air-fuel ratio may approach theoretical air fuel ratio. That is, rich combustion and the Lean combustion are made to repeat, a carbon monoxide is generated at the time of rich combustion, oxygen is generated and warming up of a catalyst is made to complete oxidation reaction with a carbon monoxide with a lifting and the heat at this time at the time of the Lean combustion. Furthermore, ECU2 sets up the 1st air-fuel ratio feedback controlled parameter (initial value of the amount of skips) for making a main air-fuel ratio into theoretical air fuel ratio, when starting catalyst warming-up processing, and when ending catalyst warming-up processing, it sets up the 2nd air-fuel ratio feedback controlled parameter (initial value of the amount of skips) for making a main air-fuel ratio into theoretical air fuel ratio. That is, the 1st air-fuel ratio feedback controlled parameter when performing catalyst warming-up processing from the condition of omitting catalyst warming-up processing (initial value of the amount of skips), The 2nd air-fuel ratio feedback controlled parameter (initial value of the amount of skips) when not performing catalyst warming-up processing from the condition of performing catalyst warming-up processing is prepared as a different value. When a switch is performed, by choosing an air-fuel ratio feedback controlled parameter, a main air-fuel ratio can be brought close to theoretical air fuel ratio more promptly.
[0064] Although the initial value of the amount of skips which is different by the existence of dither control was set up

in the above-mentioned example as application of this example, you may make it set up the value (integration constants K1 and K2) of integral processing which is different by the existence of dither control.
(The 2nd example) Next, the 2nd example is explained.
[0065] Although the initial value of the amount of skips which is different by the existence of dither control was set up in the 1st example Since the output of this example of the air-fuel ratio sensor 20 of the upstream is rich, even if it changes to Lean, it is considered that fixed time amount is rich. On the contrary, even if the output of the air-fuel ratio sensor 20 of the upstream changes from Lean richly, fixed time amount is made to perform delay processing in which it is regarded as Lean, and adjusts the above-mentioned delay processing time (delay time TD) according to the output of the air-fuel ratio sensor 21 of the downstream.
[0066] The whole configuration is the same as that of drawing 1 , and the same is said of drawing 2 and the processing of 3. An operation of this example is explained using the timing chart of drawing 13 . Drawing 9 and 10 are 1st air-fuel ratio feedback control routine which calculates the air-fuel ratio correction factor FAF based on the output of the air-fuel ratio sensor 20 of the upstream, and are performed by every predetermined time (for example, 10msec).
[0067] At step 500, it distinguishes whether the feedback control conditions of an air-fuel ratio are satisfied. Here, an engine speed Ne is below the predetermined value Neo (Ne<Neo), an intake pressure PM is below the predetermined value PMo (PM<PMo), and, as for air-fuel ratio feedback conditions, water temperature Thw says 20 degrees C or more (Thw> 20 degrees C).
[0068] And when feedback control conditions are abortive, it progresses to step 501, and the air-fuel ratio correction factor FAF is set to 1.0. On the other hand, in feedback control condition formation, it shifts to step 502.
[0069] At step 502, it is the dither distinction flag FDit. If it judges whether it is "1" and becomes FDit=0, while setting up the value TDR 1 beforehand defined as delay time TDR at step 503, the value TDL 1 beforehand defined as delay time TDL will be set up. Moreover, if it becomes dither judging flag FDit=1 at step 502, while setting up the value TDR 2 beforehand defined as delay time TDR at step 504, the value TDL 2 beforehand defined as delay time TDL will be set up.
[0070] And at step 505, A/D conversion of the output V1 of the air-fuel ratio sensor 20 of the upstream is carried out, it is incorporated, and it is step 506V1. It distinguishes whether it is below the comparison electrical potential difference VR 1 (for example, 0.45V). That is, an air-fuel ratio distinguishes Rich or Lean. If it is Lean (V1 <=VR1), "1" decrement of the delay counter CDLY is carried out at step 507, and the delay counter CDLY is guarded at the minimum value TDR by step 508,509.
[0071] On the other hand, if it is rich (V1 >VR1) in step 506, "1" increment of the delay counter CDLY is carried out at step 510, and the delay counter CDLY is guarded at Maximum TDL by step 511,512.
[0072] At step 513 of drawing 10 , it distinguishes whether the sign of the delay counter CDLY was reversed. That is, it distinguishes whether the air-fuel ratio after delay processing was reversed. If the air-fuel ratio is reversed, since rich, the reversal to Lean and the reversal to Rich from Lean will be distinguished at step 514. Since rich, if it is reversal to Lean, it will be made to increase in skip with FAF=FAF+RSR at step 515, and if it is reversal to Rich from Lean, it will be made to decrease in skip with FAF=FAF-RSL at step 516 conversely. That is, skip processing is performed.
[0073] On the other hand, if the sign of the delay counter CDLY is not reversed in step 513, integral processing is performed at step 517,518,519. That is, it distinguishes whether it is CDLY<0 at step 517, if it is CDLY<0 (Lean), it will consider as FAF=FAF+K1 at step 518, and on the other hand, if it is CDLY>=0 (rich), it will consider as FAF=FAF-K1 at step 519. Therefore, step 518 increases fuel oil consumption gradually in the state of Lean (CDLY<0), and step 519 decreases fuel oil consumption gradually in the rich condition (CDLY>=0).
[0074] Like ****, calculated FAF is stored in RAM24 and a routine is ended. Drawing 11 and 12 are 2nd air-fuel ratio feedback control routine which calculates delay time TDR and TDL based on the output of the air-fuel ratio sensor 21 of the downstream, and are performed by every predetermined time (for example, 100msec).
[0075] At step 600, it distinguishes whether the feedback control conditions of the air-fuel ratio by the air-fuel ratio sensor 21 of the downstream are satisfied, and if it is condition failure, this routine will be ended.
[0076] Moreover, if it is air-fuel ratio feedback control condition formation, it progresses to step 601 and is the output voltage V2 of the air-fuel ratio sensor 21 of the downstream. A/D conversion is carried out, and it incorporates and is the dither judging flag FDit at step 602. It judges whether it is "1."
[0077] And if it becomes FDit =0, it will be the output voltage V2 of the air-fuel ratio sensor 21 of the downstream at step 616 of drawing 12 . It distinguishes whether it is below the comparison electrical potential difference VR 2 (for

example, 0.55V). That is, an air-fuel ratio distinguishes Rich or Lean. At the time of Lean (V2 <=VR2), it is referred to as TDR1=TDR1+deltaTD (constant value) at step 617 by step 616, that is, the rich delay time amount TDR is increased, and an air-fuel ratio is made to shift to a rich side. In step 618,619, TDR is guarded at Maximum MAX. Furthermore, it is referred to as TDL1=TDL1-deltaTD (constant value) at step 620. That is, Lean delay time TDL is decreased and an air-fuel ratio is made to shift to a rich side. In step 621,622, TDL1 is guarded at the minimum value MIN.

[0078] On the other hand, when rich (V2 >VR2) in step 616, it is referred to as TDR1=TDR1-deltaTD (constant value) at step 623, that is, the rich delay time amount TDR is decreased, and an air-fuel ratio is made to shift to the Lean side. In step 624,625, TDR is guarded at the minimum value MIN. Furthermore, it is referred to as TDL1=TDL1+deltaTD (constant value) at step 626, that is, Lean delay time TDL is made to increase, and an air-fuel ratio is made to shift to the Lean side. In step 627,628, TDL is guarded at Maximum MAX.

[0079] On the other hand, if it becomes dither distinction flag FDit =1 in step 602 of drawing 11 , it will be the output voltage V2 of the air-fuel ratio sensor 21 of the downstream. It distinguishes whether it is below the comparison electrical potential difference VR 2 (for example, 0.55V). That is, an air-fuel ratio distinguishes Rich or Lean.

[0080] In step 603, it is referred to as TDR2=TDR2+deltaTD (constant value) at step 604 at the time of Lean (V2 <=VR2), that is, the rich delay time amount TDR 2 is increased, and an air-fuel ratio is made to shift to a rich side. In step 605,606, TDR2 is guarded at Maximum MAX. Furthermore, it is referred to as TDL2=TDL2-deltaTD (constant value) at step 607. That is, Lean delay time TDL is decreased and an air-fuel ratio is made to shift to a rich side. In step 608,609, TDL2 is guarded at the minimum value MIN.

[0081] On the other hand, when rich (V2 > VVR2) in step 603, it is referred to as TDR2=TDR2-deltaTD (constant value) at step 610, that is, the rich delay time amount TDR is decreased, and an air-fuel ratio is made to shift to the Lean side. In step 611,612, TDR is guarded at the minimum value MIN. Furthermore, it is referred to as TDL2=TDL2+deltaTD (constant value) at step 613, that is, Lean delay time TDL is made to increase, and an air-fuel ratio is made to shift to the Lean side. In step 614,615, TDL is guarded at Maximum MAX.

[0082] Like ****, TDR and TDL which were calculated are stored in RAM24, and this routine is ended. Thus, if the output of the air-fuel ratio sensor 21 of the downstream is Lean according to drawing 11 and the routine of 12, the rich delay time amount TDR will increase gradually, and Lean delay time TDL will decrease gradually, and, thereby, an air-fuel ratio will shift to a rich side. Moreover, if the output of the air-fuel ratio sensor 21 of the downstream is rich, the rich delay time amount TDR will decrease gradually, and Lean delay time TDL will increase gradually, and, thereby, an air-fuel ratio will shift to the Lean side.

[0083] At this time, when TDR2 and TDL2 were computed by processing at step 617,621,623,626 in drawing 12 R> 2 when there is no injection dither, and there was an injection dither, TDR1 and TDL1 were computed by processing at step 604,607,610,613 in drawing 11 . That is, two kinds of multipliers which determine delay time TD are prepared by the existence of a dither, and are chosen.

[0084] Thus, in this example, according to the output of the air-fuel ratio sensor 21, ECU2 changes the time delay of an output judging of the air-fuel ratio sensor 20 so that a main air-fuel ratio may approach theoretical air fuel ratio. And ECU2 sets up the 2nd time delay as a time delay of an output judging (Rich Lean judging) of the air-fuel ratio sensor 20, in order to make a main air-fuel ratio into theoretical air fuel ratio, when setting up the 1st time delay as a time delay of an output judging (Rich Lean judging) of the air-fuel ratio sensor 20 and ending catalyst warming-up processing, in order to make a main air-fuel ratio into theoretical air fuel ratio, when starting catalyst warming-up processing. That is, when the 1st time delay when performing catalyst warming-up processing from the condition of omitting catalyst warming-up processing, and the 2nd time delay when not performing catalyst warming-up processing from the condition of performing catalyst warming-up processing are prepared as a different value and a switch is performed, a main air-fuel ratio can be more promptly brought close to theoretical air fuel ratio by choosing a time delay.

[0085] In addition, when the amount of dithers is made adjustable, you may make it choose that dither ******** correction factor, although this invention is not limited to each above-mentioned example and the amount of dithers was made into constant value in each above-mentioned example.

[0086]

[Effect of the Invention] As explained in full detail above, according to this invention, the outstanding effectiveness which can be promptly made into theoretical air fuel ratio in the case of initiation and termination of an injection dither

is demonstrated.

[Translation done.]